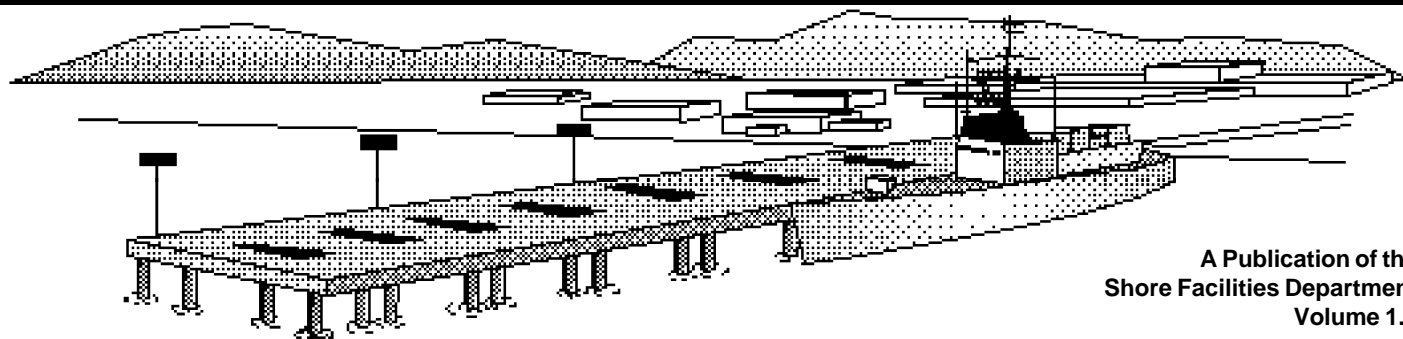




# N F E S C

Naval Facilities Engineering Command  
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Port Hueneme, CA 93043-4370

## On The Waterfront



A Publication of the  
Shore Facilities Department  
Volume 1.3

### ***HPM Technology - Less Bang for Your Buck***

On the morning of 28 June 1995, over 50 people from three countries paced the sandy high desert in the Coso Junction test range of the Naval Air Weapons Center (NAWC), China Lake, Calif. **CAPT Spangler**, Navy Safety Center, **Dr. Chester Canada**, Department of Defense Explosives Safety Board; **Bill Gibbings**, NAVFAC Headquarters, **FLT LT Tim Chapman**, Royal Australian Air Force; and **Tan Cheng-Teck** and **Koh Tong-Chia**, Singapore Ministry of Defence, were among those who had come to witness an explosives test that would be the first step towards safety certification of the High Performance Magazine (HPM). A full-scale prototype structure (1/2 of an HPM) constructed by **EFWEST** would be tested by detonation of 144 MK82 bombs (30,000 pounds of net explosives weight, NEW) in a "donor" cell. This test would demonstrate the HPM's ability to prevent sympathetic detonation of "acceptor" ordnance -- underwater mines, torpedoes, bombs, and projectiles stored in adjacent cells.

Segregated storage of ordnance is the key feature of the HPM that enables storage of incompatible ordnance within a single magazine while limiting the "maximum credible event" (the quantity of explosives that could be accidentally detonated) to a fraction of the total quantity of explosives stored in the magazine. HPM technology will dramatically reduce the real estate at the Navy's bases and weapons stations that is encumbered by explosives safety arcs (the safe inhabited building distance from an explosion to prevent injury). Using HPMs will reduce encumbered land by a factor of eight compared to standard magazines of equal storage capacity and will enable use of land that otherwise would not be available to meet BRAC realignment requirements. Close-in siting to maintenance or load-out areas will increase productivity while reducing the cost of ordnance logistics.

Much was at stake when a dust cloud mushroomed into the air and a shock wave startled the test witnesses. Post-test

inspection of the test structure debris and acceptor ordnance and analysis of test data revealed that the structure had performed as designed and that acceptor ordnance had not detonated (the thin-skinned underwater mines and torpedo warheads had burned as predicted).



HPM Storage Cell Test

(Article continued on page 2)

#### **Inside**

- ⇒ **Decision Support Systems Aid Environmental Management** ..... 2
- ⇒ **San Diego Aircraft Carrier Homeport Seismic and Geotechnical Analysis** ..... 3
- ⇒ **Don's Corner - Recycled Plastic Fender Piles** ..... 4
- ⇒ **Guest Column - Waterfront Criteria** ..... 6
- ⇒ **Naval Facilities Engineering Service Center** ..... 7

The ESC Explosives Safety team of **Jim Tancreto**, Team Leader, **Kevin Hager**, **Bob Murtha**, and **Javier Malvar** used the most modern finite element and hydrocode computer programs to develop the HPM design. The ESC team conducted extensive computer modeling of the donor ordnance explosion, magazine break-up, impact of debris on acceptor ordnance, and the resulting reaction of acceptor ordnance. This modeling technology designed modular wall building blocks fabricated from a chemically bonded ceramic material (similar to lightweight concrete). Filling the wall blocks' hollow cores with sand and a dense steel grit produced a massive and energy absorbing wall that was affordable, easy to build, and prevented sympathetic detonation of acceptor ordnance.

The dedication of **Sharon Topping**, **Ron Brody**, **Sid Grant** and the contracts office at EFAWEST led to the quick turn-around of lessons learned from the first certification test into the design for the final certification test structure. EFAWEST awarded a contract in

December 1995 for construction of the second full-scale prototype at NAWC China Lake, Calif. This final test scheduled for October 1996 will certify safety for the scenario of accidental detonation of ordnance in an open storage cell and in the shipping and receiving area during a loading operation. Successful completion of this test will lead to DDESB certification of standard HPM designs in FY97.

You do not have to wait to benefit from HPM technology. ESC engineers are using advanced modeling techniques and the ordnance reaction threshold database to develop affordable and imaginative ways to resolve limitations on ordnance logistics imposed by safety arcs. For example, working with **PACDIV** planning staff, the Explosives Safety Team completed a study to optimize storage of ordnance in five tunnel magazines and to safely site three new magazines at **MCB Kaneohe Bay, Hawaii**. The team used recent NAVSEA OP-5 criteria as the basis for the study and recommendations to revise storage

plans and explosives safety quantity distance arcs for five tunnel magazines that overlook base housing and a playground. HPM modeling technology confirmed the safety of the new magazine loading plan and siting. **Byrnes Yamashita**, **PACDIV** Planning, and **Jim Tancreto** are now developing a design for a new type of ready issue magazine that will use HPM wall technology to segregate ordnance storage into cells. The ready modular magazine will have a 2,500-pound NEW capacity with only a 500-pound NEW maximum credible event; thus, the explosives safety arc will be reduced. The new ready modular magazine will support ordnance logistics activities close to the flight line at MCB Kaneohe Bay to perform functions for the Anti-Submarine Warfare mission that was transferred to MCB Kaneohe Bay from NAS Barbers Point by a BRAC closure action.

For more information, contact **Jim Tancreto**, ESC62, DSN 551-1180, (805)982-1180, or Internet: [jtancr@nfesc.navy.mil](mailto:jtancr@nfesc.navy.mil).

## Decision Support Systems Aid Environmental Management

The **Environmental Department** of the **Marine Corps Base Hawaii** (MCBH) is using a Decision Support System, developed by ESC's **Facilities Systems Division**, to manage the environmental, cultural, and historical resources on the Mokapu Peninsula on O'ahu. In April, the department, lead by **Major Paul D'Antonio**, received the **DOD Natural Resources Conservation Award** in recognition of their work as stewards of this precious site.

The MCBH is responsible for 700 acres (approximately 25 percent) of the Mokapu Peninsula. This area contains a wealth of unique natural, historical cultural assets. It is a core breeding area for the endangered Hawaiian stilt, is home to three other endangered Hawaiian water birds, and a variety of native and migratory shorebirds; seabirds; waterfowl; and fish. The shoreline sediments at Ulupa'u Crater contain a unique deposit of fossil marine shells of a now-extinct gastropod dated to 120,000 years ago. Fishpond walls, which connect the peninsula with the rest of O'ahu, were built by the earliest Polynesian settlers at least 1,000 years ago. The dune complex along the north shore of the peninsula is the largest known concentration

of native Hawaiian burials in the state. Many MCBH facilities stand in silent memory of World War II.

At the hub of the MCBH environmental management center is the AutoCAD-based multimedia Decision Support System. The information system is comprised of AutoCAD drawings and scanned images integrated through DataMgr, a multimedia data management program. **Karol Scott**, of the Facilities Systems Division, is currently working with the Head of the MCBH Environmental Affairs Division, **Dr. Diane Drigot**, to expand the system into a full Geographic Information

(Article continued on page 3)

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If you have any comments or questions, suggestions for future articles, or would like to receive copies of "On the Waterfront," call or write to **Mr. Preston Springston**, Code ESC60, (805) 982-1225; DSN: 551-1225; FAX: (805) 982-3481, or Internet: [pspring@nfesc.navy.mil](mailto:pspring@nfesc.navy.mil).





Selected CAD layers exported to shape files.

System (GIS). The GIS will house audio/visual histories, scientific data, general information, and an integrated land use management plan. It will use the latest Installation Lifecycle Management (ILM) technologies to analyze and display the results of Dr. Drigot's efforts in managing this thriving portal to the past and future.

Over the past ten years, ESC, along with Geo InSight International, Inc., has been instrumental in developing MCBH's Decision Support System. The system has been used for tracking the effects of

mangrove removal on the Hawaiian stilts in Nu'upia Ponds, and restoring native, low maintenance vegetation to Ulupa'u Head. The information system project started with a desire to effectively manage the natural/cultural resources and gleaned funds, and has grown to a nationally recognized program with Legacy funding and incentive awards.

Could you use a GIS to assist your activity with analysis of day-to-day management issues? Would multimedia help to present your efforts in natural/cultural resource management? Or do you have need for newly developed base maps? The Facilities Systems Division provides planning and implementation of the ILM technologies, and multiple methods of obtaining expertise. Services include:

- **Planning and Program Support**, such as user requirements and surveys, evaluation of current mapping, remote sensing, and facilities management uses and technologies.
- **Technical Analysis and Product Development**, like GIS-ready mapping using conventional photogrammetric or orthophotographic methods, remote sensing, and related engineering analysis.
- **Technology Transfer**, by producing interactive demonstrations, technical documents, or briefings.

For further information or assistance, contact **Ms. Karol Scott**, ESC64, DSN 551-1677, (805) 982-1677, or Internet: kscott@nfesc.navy.mil.

## San Diego Aircraft Carrier Homeport Seismic and Geotechnical Analysis

In 1993, **Southwest Division, NAVFAC**, awarded A/E firms the design of the Aircraft Carrier Homeport Project at the Naval Air Station North Island, San Diego, Calif. This new waterfront facility, which will berth Nimitz class aircraft carriers, includes two Military Construction Projects:

- A 2,100-foot long rock dike for containing on-site dredging materials (P-549).
- A pile supported reinforced concrete wharf deck about 1,300 feet long and 90 feet wide, (P-700).

In 1994, **Dr. Arthur Wu**, in the Office of the Chief Engineer, ESC, was tasked by the Southwest Division to perform an independent geotechnical engineering and seismic hazard analyses of the dike and wharf to ensure that the projects are designed with an acceptable risk level and accomplished with effective construction.

The Southwest Division Project Manager is **Mr. John Coon**. **Ms. Wendy Thornton** is the project engineer for the wharf. **Mr. Howard Crider** is the project manager for the dike. **Mr. John Ferritto**, **Dr. Ted Shugar**, and **Dr. Tom Lin**, all research engineers at ESC, provided assistance during these projects.

The ESC engineers worked as a team with the Southwest Division project engineers to evaluate:

- Probability of the site-specific earthquake event and ground acceleration.
- Dike slope stability and dike displacement that may be induced by design earthquake.
- Construction sequence of the rock dike and the stability of the hydraulic fill to be placed behind the dike.

This issue of Don's Corner focuses on a new fendering product for use in the waterfront.

### RECYCLED PLASTIC FENDER PILES

Fender piles are usually made of timber. To increase the life of piles, the timber is treated with chemicals to protect it from marine borer attack. The chemicals make the piles last longer but there are many environmental concerns, especially at the state and local level, regarding their use. **Dave Hoy**, of the Waterfront Materials Division, is conducting a project to determine if recycled plastic fender piles are a suitable alternative to timber fender piles. The project consists of three phases. **Phase I** is a search into the state-of-the-art in recycled plastic fender piles, surveys of current use of plastic piles, and assessment of the survey findings. **Phase II** is pile structural tests. **Phase III** is the material testing of the recycled plastic materials.

The results of the project so far show that while recycled plastic fender piles have advantages, the ESC can't recommended their use as a universal solution. The plastic piles eliminate the environmentally hazardous chemicals and may have longer lives, however, their initial cost is two to three times higher than timber piles. Other fender alternatives, such as prestressed concrete fender piles, may offer the best energy absorption at the least life cycle cost. If you are currently planning a project to install or replace fender piles, ESC engineers can help you evaluate all economic and performance factors to determine the best fendering solution for your Fleet customer.

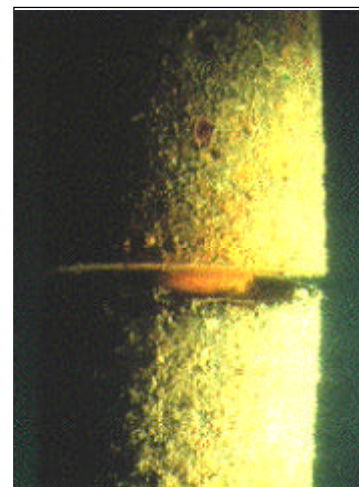
The best current use of the recycled plastic piles can be seen at the Naval Station, San Diego. **Public Works Center, San Diego**, has installed several piers with prestressed concrete piles and Seaward's Seacushion as the primary fendering system and recycled plastic fender piles as the secondary fendering system. **Dave Nunley** and **Caesar Reyes** from the Public Works Center have been helpful in providing information about their fendering system.



Recycled plastic and reinforced concrete fender piles at Naval Station, San Diego.

**Phase I** of the ESC's assessment began with a search for state-of-the-art recycled plastic fender piles. The search revealed that three companies manufactured these products. It also revealed that there were no published reports on their performance other than the manufacturer's own brochures. Surveys were conducted at both Navy and commercial harbors where the recycled plastic fender piles had been installed. **Al Emond**, Branch Manager of the Maintenance Department for the **Public Works Center, Pearl Harbor**, provided valuable information on the use of the plastic piles at Pearl Harbor. These installations all represent demonstration projects by the individual activities and provided qualitative performance information.

The first recycled plastic fender pile was installed at the Port of Los Angeles in 1987. Most of the other 350 plastic piles at the surveyed sites were installed in 1991 or later. Nearly all the piles were the sectional pipe pile. That is, individual sections were joined together at the site to form the completed pile of the required length. Some of these piles experienced problems with the jointed sections. The piles broke at the joints either because of ship impact or because they were driven while not completely joined. Some piles had water in the center of the pipe cores, which could lead to corrosion problems. For these reasons, the manufacturer discontinued manufacturing sectional piles and is now making piles out of one continuous piece sealed at the top. Material testing on the piles indicated that there may be some degradation of the plastic. However, no signs of marine borer attack were visible on the recycled plastic fender piles.



Damaged hammer sectional pipe pile at the SUBASE, Pearl Harbor.

Results of the Phase I surveys were used to refine the test plans for Phases II and III. Because there was a lack of hard data on plastic piles, tests on both the structural integrity of the piles and the durability of the recycled plastic material in the marine environment were necessary. The structural tests included flexural load tests to failure and cyclic tests to determine the stiffness (EI), load/deflection, linearity, hysteresis, energy absorption, degradation, and failure mode.

Phase II tests have been conducted, the data have been analyzed, and the report will be published in a few months. The tests showed that the recycled plastic fender piles are able to absorb more energy than timber piles but are not as stiff. This could present a problem. If the fender pile deflects too much, the fender pile could be pushed into the bearing piles. A plastic fender can, however, be made stiffer by using larger reinforcing or more piles.

Dave Hoy is currently conducting Phase III of the project to determine the long term durability of the recycled plastic fender piles. Accelerated laboratory tests are being conducted to determine

(Continued on page 5)



- Wharf pile length, pile driving feasibility, and wharf stability under the design earthquake load.

The following technologies and tools were used in the ESC team's engineering analysis.

- Site seismicity and probabilistic seismic hazard analyses.
- SHAKE computer analysis for the linear seismic response of layered soil deposits.
- STABL computer program for dike slope stability analysis.
- LIQUFAC computer analysis for hydraulic fill liquefaction potential analysis.

- Newmark methodology for computation of seismically induced dike deformation.
- MathCad computer analysis for pile length estimation.

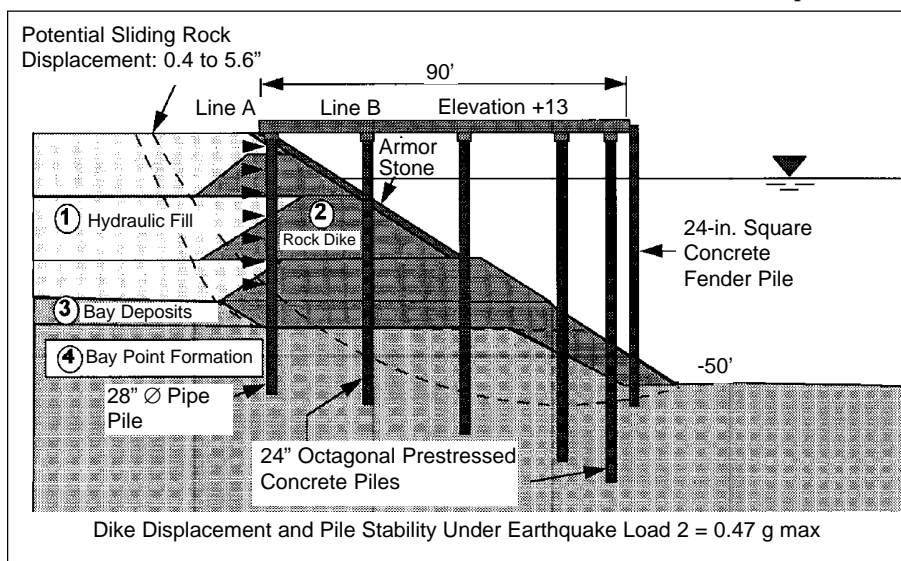
A report titled "Seismic Hazard Study and Geotechnical Engineering Analysis" was submitted to SouthWest Division in July 1995. For quality control during construction, the report recommended: (1) Control dike material gradation, (2) inspect piles using Pile Driving Analyzer (PDA), and (3) monitor the deformation of the dike and piles with instrumentation.

Valuable experience and lessons were learned from the analysis of this unique project. The team work provided effective analysis and coordination. **Dr. Get Moy**, NAVFAC Chief Engineer, wrote appreciation letters to the Commanding Officer of Southwest Division expressing thanks for the cooperation and assistance of **Mr. Coon**, **Mr. Cider**, and

**Ms. Thornton**. The technologies and tools, which were used in this analysis, can be incorporated into the NAVFAC Geotechnical Engineering design manual DM-7.03, and will be used to improve future construction of the Navy's waterfront facilities projects.

The rock dike was designed by Moffatt & Nichol Engineering, and the wharf by Ferver Engineering. Woodward-Clyde served as the geotechnical consultant to both of the design A/E firms. The construction of the facility began in the spring of 1996.

For more information, contact **Dr. Arthur Wu**, ESC61, DSN 288-8759, (202) 433-8759, or Internet: [ahwu@efaches.navy.mil](mailto:ahwu@efaches.navy.mil).



Dike and Wharf Section

(Continued from page 4)

resistance to ultraviolet, abrasion, and freeze/thaw. Some of the test piles have developed cracks in the recycled plastic material. It has not yet been determined if this is a material problem or a quality control problem. The testing will help answer this question and others as to the durability of these piles. The work is scheduled for completion by the end of the calendar year.

The ESC is also involved in work related to the Navy-sponsored projects on recycled plastic fender piles. One project is an Army Construction Productivity Advancement Research Project (CPAR) on composite pilings. This project includes the participation of the **Composites Institute**. Members of the ESC have also participated on several panels to help develop and promote new fendering systems. One panel was sponsored by the Highway Innovative Technology Evaluation Center (HITEC), a service center of the **Civil Engineering Research**

**Foundation (CERF)**, to evaluate Seaward International's recycled plastic seapile. Another panel is being funded by the **Ben Franklin Technology Center** to investigate the potential use of a glass fiber polyester tube that is filled with a light weight concrete. This pile is attractive because it may behave like a reinforced concrete pile without having any corrosive elements.

The ESC is investigating innovative fendering systems to improve the Navy's readiness by reducing maintenance costs and down time. These systems may include some of these piles or others, such as "wood composites," which are being developed.

For further information or assistance, contact **Dave Hoy**, ESC64, DSN 551-1062, (805) 982-1062, or Internet: [dhoy@nfesc.navy.mil](mailto:dhoy@nfesc.navy.mil).

# Guest Column

## Waterfront Criteria

by  
Dave Curfman  
Special Assistant for Waterfront and Harbor  
NAVFAC Criteria Office

Criteria define how NAVFAC engineering work gets done. The NAVFAC Criteria Office is currently involved in over a dozen initiatives to revise and update waterfront criteria. Because of their in-house expertise, the ESC Shore Facilities Department is providing valuable assistance on several of these initiatives. For example, **Doug Burke**, a member of the Waterfront Materials Division (ESC63) and new chair of ASTM A775, is producing a guide specification on epoxy-coated reinforcing steel. The Criteria Office is applying his research on two field projects to monitor the impacts and maintain quality control. Lessons learned will be used to finish the guide specification for designer use.

Additionally, **Frank (Skip) Johnson**, of the Waterfront Structures Division (ESC62), is revising the fixed mooring analysis program -- FIXMOOR. ESC previously developed a "Beta" (test) version of FIXMOOR. Unfortunately, funding was never available to complete the program and many engineers continued to use it. In FY95, the NAVFAC Criteria Office programmed funds to complete the software. Consequently, we should soon have a Windows-based program that will assist designers in fixed mooring design and provide engineering assistance to port operators. Skip is also working on an updated and electronic version of DM 26.6. Graphics will be retrievable for designer use.

**David Hoy**, a member of the Waterfront Materials Division (ESC63), is the ESC principal investigator for recycled plastic fender piles. He is working with the Criteria Office to evaluate the products on the market for material and structural compatibility with the Navy waterfront. If the products prove successful, he will develop a guide specification for the manufacture and installation of this innovative material.

The Criteria Office is also working with **Manmohan Chawla**, of the Chief Engineer's Office (ESC61), to develop a marine concrete guide specification. This specification will include cutting edge technology to increase the durability of marine structures.

Through contract, the Criteria Office ship characteristics database is nearly complete. This database will present electronically the ship information contained in many of the handbooks and manuals. The user will be able to retrieve physical and shore services characteristics on virtually any ship in the Navy. A designer can also generate any of the ship characteristics tables found in the design manuals or query the database for ships that possess user-defined limits within a user-defined range. This database will serve as the database for FIXMOOR and will be updated annually by the Criteria Office.

Design criteria must remain current to be most effective.



Through collaboration with ESC, NAVFAC Waterfront Criteria will continue to incorporate innovative technologies and lessons learned. If you have items that would benefit from revised or new design or maintenance criteria, or you have innovative technical solutions to recurring waterfront problems, contact the NAVFAC Criteria Office.

For further information or assistance, contact **David Curfman**, NAVFAC Criteria Office, DSN 262-4203, 804-322-4203, Fax 322-4416 or Internet: [curfman@efdlant.navy.mil](mailto:curfman@efdlant.navy.mil); or contact, **John Lynch** at 804-322-4207.

### PUTTING US TO WORK FOR YOU!!

**ESC is a DBOF organization with some interim Mission Management components. To put us to work for you, call the technical department, division, or individual engineer or scientist to begin developing a scope of work and a cost estimate. We accept funds on SF2275 and SF2276.**

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# Naval Facilities Engineering Service Center

## Mission

We are the Navy's center for specialized facilities engineering and technology. In partnership with our customers we deliver quality products and services in:

- Shore, Ocean, and Waterfront Facilities
- Environment
- Amphibious and Expeditionary Operations
- Energy and Utilities

As a member of the NAVFAC team, we provide worldwide support to:

- NAVFACHQ, EFDs/EFAs, and PWCs
- Fleet and Shore Activities
- Marine Corps
- SYSCOMs/Claimants
- SECNAV/CNO
- Other DOD Agencies

We provide solutions to problems through engineering, design, construction, consultation, test and evaluation, technology implementation, and management support. We leverage technology to enhance the effectiveness and efficiency of our customers. We use existing technology where we can. We identify and adapt breakthrough technology when appropriate. We perform research and development when required to meet Navy and Marine Corps needs.

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